Dispatcher-Assisted Cardiopulmonary Resuscitation and Survival in Cardiac Arrest

Thomas D. Rea, MD, MPH; Mickey S. Eisenberg, MD, PhD; Linda L. Culley, BA; Linda Becker, MA

Background—Early cardiopulmonary resuscitation (CPR) improves survival in out-of-hospital cardiac arrest, and dispatcher-delivered instruction in CPR can increase the proportion of arrest victims who receive bystander CPR before emergency medical service (EMS) arrival. However, little is known about the survival effectiveness of dispatcher-delivered telephone CPR instruction.

Methods and Results—We evaluated a population-based cohort of EMS-attended adult cardiac arrests (n=7265) from 1983 through 2000 in King County, Washington, to assess the association between survival to hospital discharge and 3 distinct CPR groups: no bystander CPR before EMS arrival (no bystander CPR), bystander CPR before EMS arrival requiring dispatcher instruction (dispatcher-assisted bystander CPR), and bystander CPR before EMS arrival not requiring dispatcher instruction (bystander CPR without dispatcher assistance). In this cohort, 44.1% received no bystander CPR before EMS arrival, 25.7% received dispatcher-assisted bystander CPR, and 30.2% received bystander CPR without dispatcher assistance. Overall survival was 15.3%. Using no bystander CPR as the reference group, the multivariate adjusted odds ratio of survival was 1.45 (95% confidence interval [CI], 1.21, 1.73) for dispatcher-assisted bystander CPR and 1.69 (95% CI, 1.42, 2.01) for bystander CPR without dispatcher assistance.

Conclusion—Dispatcher-assisted bystander CPR seems to increase survival in cardiac arrest. (***Circulation***. 2001;104: 2513-2516.)

Key Words: heart arrest ■ cardiopulmonary resuscitation ■ arrhythmia ■ resuscitation ■ death, sudden

O f the ≈250 000 persons who experience an out-of-hospital cardiac arrest each year in the United States, only an estimated 5% survive to hospital discharge.[1,2] Early cardiopulmonary resuscitation (CPR) improves the likelihood of survival,[3] yet only one-third of persons typically receive CPR before the arrival of emergency medical services (EMS).[4–6] Dispatcher-delivered instruction in CPR can increase the proportion of arrest victims who receive citizen CPR before EMS arrival.[7] Simulation studies suggest that bystanders without prior CPR training who receive dispatcher instruction demonstrate comparable CPR skills to previously trained persons, although more time elapses between collapse and the initiation of CPR in the former group.[8] In the real-life arrest settings, however, little is known about the survival effectiveness of dispatcher-delivered telephone CPR instruction. In addition to affecting time from collapse to CPR, CPR that requires dispatcher instruction in the real arrest event may be associated with the quality of CPR; this factor seems to influence survival in out-of-hospital cardiac arrest.[4] To examine the effectiveness of dispatcher-delivered telephone CPR instruction for out-of-hospital cardiac arrest, we determined the association between survival and 3 distinct CPR groups: no bystander CPR before EMS arrival (no bystander CPR), bystander CPR before EMS arrival requiring dis-patcher instruction (dispatcher-assisted bystander CPR), and bystander CPR before EMS arrival not requiring dispatcher instruction (bystander CPR without dispatcher assistance).

Methods

Study Setting and Population

The study setting was suburban King County, Washington (population, 1.1 million). This area is served by a 2-tiered EMS response system. The first tier consists of fire engines or aid units staffed with fire fighters who are trained in basic life support (BLS) and are capable of providing defibrillation using automated or manual defibrillators. The second tier consists of emergency units staffed with paramedics who are trained in advanced life support (ALS) care. In the case of a suspected cardiac arrest, first and second tier units are dispatched simultaneously and, upon scene arrival, follow the American Heart Association BLS and ALS guidelines.[9] Since 1975, the EMS (BLS and ALS) reports and the dispatch tape recordings for each EMS-attended cardiac arrest event have been reviewed to determine demographics, event circumstances, cardiac rhythms, specific therapeutic interventions, and immediate outcome (admit to hospital versus death). Hospital records and death certificates, in addition to EMS records, are used to determine the cause of the cardiac arrest and to ascertain long-term survival. This data set has been standardized to the Utstein guidelines.[10a]

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TABLE 1. Demographic and Arrest Characteristics by CPR Group

Characteristic	No Bystander CPR (n=3205)	Dispatcher-Assisted Bystander CPR (n=1867)	Bystander CPR Without Dispatcher Assistance (n=2193)
Age, y	69.7±13.0	67.0±12.7	68.7±13.2
Male sex, n (%)	2220 (69.3)	1274 (68.2)	1560 (71.1)
Location, n (%)			
Home	2589 (80.8)	1747 (93.6)	839 (38.3)
Public	448 (14.0)	107 (5.7)	759 (34.6)
Medical*	129 (4.0)	13 (0.7)	497 (22.7)
Indeterminate	39 (1.2)	0 (0)	98 (4.4)
Witnessed arrest, n (%)	1384 (43.2)	1002 (53.7)	1274 (58.1)
BLS interval, min†	5.1±2.3	5.6±2.2	5.0±2.5
ALS interval, min†	10.4±5.0	10.1±4.5	9.5±4.6
Collapse to 911 call interval, min‡	1 (1,2)	1 (1,1)	1 (1,2)
Collapse to CPR interval, min‡	6.4±3.1	2.9±2.4	2.0±1.7

*Includes medical clinics and nursing facilities.
†Interval from call to arrival on scene.
‡Among witnessed arrests.
Values are mean±SD, n (%), or median (25th, 75th percentile).

The first full year of the dispatcher CPR program was 1983; thus, the present analysis was conducted using data from 1983 through 2000. In addition, we excluded (1) persons who experienced an arrest after the arrival of EMS, because it would not be possible for these persons to have received the exposure of interest (bystander CPR) and (2) persons <18 years of age. Of the 7945 persons who experienced an arrest due to cardiac causes and were initially eligible, covariate information was missing for 680 persons, leaving 7265 subjects (91.4%) for analysis. The study was approved by the institutional review committee.

Study Outcome
The outcome of this study was survival to hospital discharge.

Exposure Status
The exposure of interest, CPR status, was determined from the EMS records and dispatch tapes. For each case, information was collected regarding whether bystander CPR was provided before EMS arrival, who performed the bystander CPR (lay persons versus medical professionals, ie, nurse or physician), and whether dispatch instruction was required to perform CPR. Emergency medical dispatchers follow an established set of criteria to identify cardiac arrest cases. Once cases are identified, dispatchers ask if anyone on scene knows how to perform CPR. If no one is able to perform CPR, the dispatcher offers to provide instruction. This instruction provides explicit direction in CPR and has been described in detail previously.[7,10b,11] For both bystander CPR groups, CPR was considered to have been performed if initial rescue breaths were delivered by the bystander. Using these methods, each case was classified into 1 of 3 categories: no bystander CPR before EMS arrival, dispatcher-assisted bystander CPR before EMS arrival, and bystander CPR without dispatcher assistance before EMS arrival. In addition to CPR status, information is available regarding demographic and arrest characteristics that may potentially influence the outcome of cardiac arrest, including age, sex, witness status, location of the arrest (private residence, public location, medical facility, or indeterminate), presenting rhythm, and interval from collapse to 911 call, interval from collapse to CPR, and interval from call to EMS (BLS and ALS) arrival at the scene.

Statistical Analysis
The univariate association between survival and CPR status was determined using the χ^2 test. Logistic regression was used to estimate odds ratios of survival for the 3 CPR groups while adjusting for other factors that may potentially influence survival. Subjects that received no bystander CPR before the arrival of EMS personnel were the reference group. Multivariate analyses were adjusted for age, sex, witness status, location, and time to BLS arrival. Subgroup analyses evaluated whether the association between survival and CPR status differed among specific demographic or arrest-characteristic subgroups. These potential subgroup differences were modeled using cross-product terms between the covariates of interest and CPR status. Among witnessed arrests (a group with a known collapse time), we specifically hypothesized that dispatcher-assisted bystander CPR might be less beneficial when EMS arrives quickly because of the delay to CPR produced in delivering instructions; thus, we evaluated the association between survival and CPR status when EMS arrived within 3 minutes from time of call, 4 minutes from call, and ≥5 minutes from call.

We also evaluated the potential mechanism by which bystander CPR may confer survival benefit. In doing so, we included the interval from collapse to CPR in the statistical model (restricted to witnessed arrests). One may estimate the relative contribution of the interval from collapse to CPR by first computing the β coefficient values for the bystander CPR terms in the model unadjusted for the interval from collapse to CPR ($\beta_{baseline}$), and then by calculating the β coefficient values for the bystander CPR terms in the model adjusted for the interval from collapse to CPR ($\beta_{adjusted}$). The relative contribution of this mechanism is then calculated using the expression: $1-(\beta_{adjusted}/\beta_{baseline})$.[12] The interval from collapse to CPR was modeled as a continuous term in this analysis.

Results
In this cohort of 7265 persons who experienced cardiac arrest due to cardiovascular causes, 44.1% of subjects received no bystander CPR before EMS arrival, 25.7% received dispatcher-assisted bystander CPR, and 30.2% received bystander CPR without dispatcher assistance. No temporal trends were observed for CPR status. Cardiac arrest cases who received dispatcher-assisted bystander CPR tended to be younger, occur in private residences, and require a greater duration for BLS response compared with those who did not receive bystander CPR and those who received bystander CPR without dispatcher assistance (Table 1). Among wit-

TABLE 2. ORs of Survival in Out-of-Hospital Cardiac Arrest According to CPR Group

Characteristic	Survivors, n	Fatal Arrest, n	Unadjusted OR (95% CI)	Multivariate OR (95% CI)*
No bystander CPR	361	2844	1	1
Dispatcher-assisted bystander CPR	283	1584	1.41 (1.19, 1.66)	1.45 (1.21, 1.73)
Bystander CPR without dispatcher assistance	470	1723	2.15 (1.85, 2.50)	1.69 (1.42, 2.01)

*Adjusted for age, sex, witness status, location, and BLS response time.

nessed arrests, mean time from collapse to CPR for the dispatcher-assisted bystander CPR group was ≈1 minute more than for the bystander CPR group without dispatcher assistance ($P=0.001$).

Overall survival was 15.1%. Both dispatcher-assisted bystander CPR and bystander CPR without dispatcher assistance were associated with increased odds of survival compared with no bystander CPR in univariate and multivariate analyses (Table 2). Exclusion of medical professionals from the bystander CPR group without dispatcher assistance did not change the relationship (odds ratio [OR], 1.72; 95% confidence interval [CI], 1.44, 2.06 for layperson CPR without dispatcher assistance compared with no bystander CPR). Similarly, further adjustment for ALS response time altered the associations only slightly. The survival advantage evident in the univariate analysis for the group who received bystander CPR without dispatcher assistance compared with the group who received dispatcher-assisted bystander CPR (OR, 1.53; 95% CI, 1.30, 1.80; $P=0.001$) was attenuated in the multivariate model (OR, 1.17; 95% CI, 0.96, 1.42; $P=0.1$). The association between CPR status and survival did not differ across subgroups defined by sex, age (≤65 and >65 years), or witness status. Among those who had a witnessed arrest, the relative survival benefit associated with dispatcher assistance increased as the BLS response time increased (Figure). Adjustment for the interval from collapse to CPR (among witnessed arrests) attenuated the associations between survival and bystander CPR (Table 3). This model suggests that the majority of the survival benefit associated with bystander CPR can be explained by reducing the interval from collapse to CPR.

Discussion

In this large, population-based cohort of EMS-attended out-of-hospital cardiac arrests, dispatcher-assisted bystander CPR was associated with an ≈50% improvement in the odds of survival compared with those who received no CPR before EMS arrival; this survival benefit approached that of bystander CPR without dispatcher assistance. Low rates of bystander CPR may be due to several factors, including lack of prior CPR instruction, fear of communicable disease, or event anxiety.[13–15] Dispatcher-assisted bystander CPR is one means to address these obstacles. On the basis of our experience, dispatcher-assisted bystander CPR is associated with a 25% absolute increase in the proportion of arrest victims who receive bystander CPR (30% to 55%). Consequently, given the large public health impact of sudden cardiac death, the improved survival associated with

dispatcher-assisted bystander CPR is clinically important and could potentially save thousands of lives annually.

Both the quality of bystander CPR and the interval from collapse to CPR have been associated with survival in out-of-hospital cardiac arrest. Our results suggest that dispatcher-assisted bystander CPR and bystander CPR without dispatcher assistance improve survival, in large part, by reducing the interval from collapse to CPR. Similarly, the modest survival advantage for bystander CPR without dispatcher assistance compared with dispatcher-assisted CPR may be explained by differences in the quality of CPR or the interval from collapse to CPR between the 2 groups. No assessment of the quality of bystander CPR was available for this analysis; however, given the survival differences among witnessed arrests between the 2 bystander CPR groups when EMS response times were short (≤3 minutes, a duration typically required to deliver and institute dispatcher-assisted CPR[7]) and survival similarities when EMS response times were longer (>5 minutes), our results suggest that the quality of bystander CPR is comparable between the 2 bystander groups and that the time-delay associated with dispatcher-assisted CPR may be a more important factor.
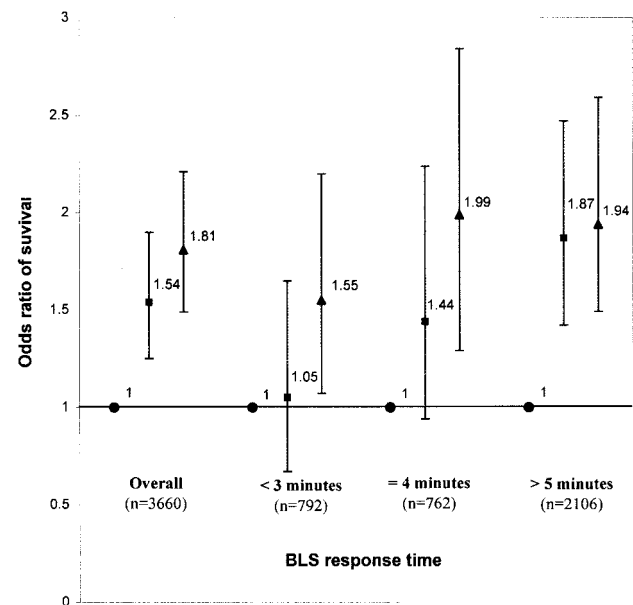
Multivariate adjusted odds ratio of survival by CPR status and BLS response time in witnessed cardiac arrest. No bystander CPR is the reference group for each BLS response-time category. ●, No bystander CPR before EMS arrival; ■, dispatcher-assisted bystander CPR; ▲, bystander CPR without dispatcher assistance.

TABLE 3. Mechanism of Benefit Associated With Bystander CPR in Witnessed Cardiac Arrest

	OR in Baseline Model*	β in Baseline Model	OR in Model Adjusted for Time From Collapse to CPR	β in Adjusted Model	Portion of Benefit Attributable to Decreased Time From Collapse to CPR, %†
Dispatcher-assisted CPR (n=1002)	1.54	0.433	1.14	0.131	69.7
CPR without dispatcher assistance (n=1274)	1.81	0.592	1.29	0.252	57.4

*Referent group is those persons who received no CPR before EMS arrival (n=1384). Baseline model adjusted for age, sex, location, and BLS response time.
†Percent calculated from the equation $\{1-(\beta_{adjusted}/\beta_{baseline})\}\times100$.

Dispatch instruction in this study included ventilation and chest compression. The most recent guidelines of the American Heart Association recommend that dispatcher instruction of untrained bystanders be limited to chest compression only and exclude ventilations.[11] This simplification is designed to increase the proportion of cardiac arrest victims who receive bystander CPR while decreasing the interval required to institute CPR. In adult cardiac arrest of relatively short duration (an average response interval of 4 minutes), bystander CPR with only chest compression seems to be as effective as bystander CPR with ventilation and chest compression.[16] Whether this effectiveness extends to the longer durations of bystander CPR typical of most out-of-hospital cardiac arrests is uncertain, although some animal models support the comparability of the 2 methods in longer arrest settings.[17,18] If dispatcher-assisted bystander CPR with chest compression alone maintains CPR effectiveness while increasing the proportion of arrest victims who receive CPR, it would further increase the public health impact of dispatcher instruction.

Our study has limitations. Despite efforts to minimize confounding in the analysis of the study data, we cannot exclude the possibility of uncontrolled confounding. Our study was based on the experience of an EMS system with comparatively quick response times; therefore, our results may not be generalizable to all communities. However, the relative survival benefits of dispatcher-assisted bystander CPR seem to increase as response time increases. We did not have complete information on neurological function among survivors. Given the differences in time from collapse to CPR between the 3 CPR groups, there may be potential differences in neurological outcome, although the neurological status of the dispatcher-assisted CPR group would presumably be at least as good as arrest survivors who received no bystander CPR.[19]

Dispatcher-assisted bystander CPR is associated with improved survival in out-of-hospital cardiac arrest compared with those who received no bystander CPR before EMS arrival. Consequently, emergency medical dispatchers should be trained to provide CPR instructions and readily offer these instructions during a cardiac arrest. Future efforts should be aimed at increasing the proportion of cardiac arrest victims who receive effective bystander CPR. Strategies of dispatcher instruction that simplify the CPR algorithm and address bystander concerns yet maintain the effectiveness of CPR may help achieve this aim.

Acknowledgments

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